Statement of Work

Heatshield for Extreme Entry Environment Technology (HEEET) Composite Carrier Structure

HEEET-4007
Revision A

04/01/2015

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, California

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1 SCOPE

This Statement of Work (SOW) defines the effort required for engineering and manufacturing of various flat composite panel test coupons, tooling, and fittings, and ultimately two composite carrier structures for the Heatshield for Extreme Entry Environment Technology (HEEET) project, intended for engineering testing. While the structure will not see spaceflight use, the procedures and processes shall conform to typical spaceflight processing requirements, except as noted. This document shall describe the scope, background, applicable documents, requirements, and associated program management needed to complete the tasks required by the Government.

1.1 BACKGROUND

The HEEET Project, co-funded by NASA's Space Technology Mission Directorate under the Game Changing Development Program (GCDP) and NASA's Science Mission Directorate (SMD), seeks to mature a game changing Woven Thermal Protection System (WTPS) technology to enable in-situ robotic science missions recommended by the NASA Research Council (NRC) Planetary Science Decadal Survey (PSDS) committee. A primary deliverable for the HEEET Project is an Engineering Test Unit (ETU). A flight-like woven TPS heat shield will be assembled on a flight-like carrier structure and put through a series of environmental tests. There are four primary goals associated with the development, manufacturing, and testing of the ETU:

1. Verification of structural performance of ETU and model correlation
2. Demonstration of manufacturability at a 1 meter scale
3. Demonstration of inspection and defect identification of entire heat shield at 1 meter scale
4. Demonstration of NASA's ability to transfer prototype component manufacturing insight to outside partners, levy efficient and effective requirements, and verify that delivered hardware is acceptable

To accomplish these goals, the Project is building a 1 meter Engineering Test Unit (ETU). The ETU will consist of a tiled woven TPS system assembled on a representative carrier structure. The ETU will be designed and constructed to satisfy the demanding flight environments of a Saturn probe of this size. It will utilize flight like materials, design practices, and manufacturing rigor where appropriate.

The primary deliverable from this SOW is the carrier structure (quantity 2). A representative carrier structure is shown in figure 1 and 2 below. The assembly is a carbon composite sphere-cone entry vehicle consisting of a solid carbon fiber shell and a metallic ring structure. The Metallic Ring structure, is bolted to the carrier structure skin.

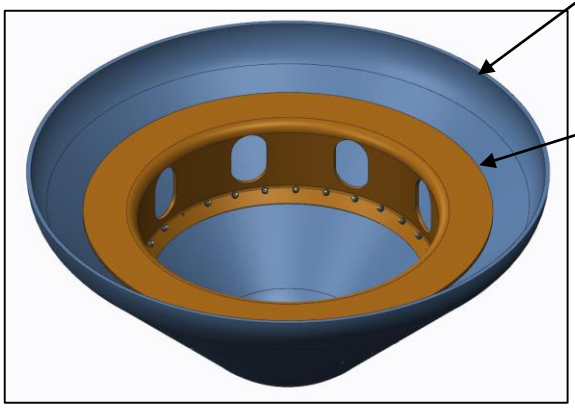

Figure 1 - Carrier Structure - Isometric View

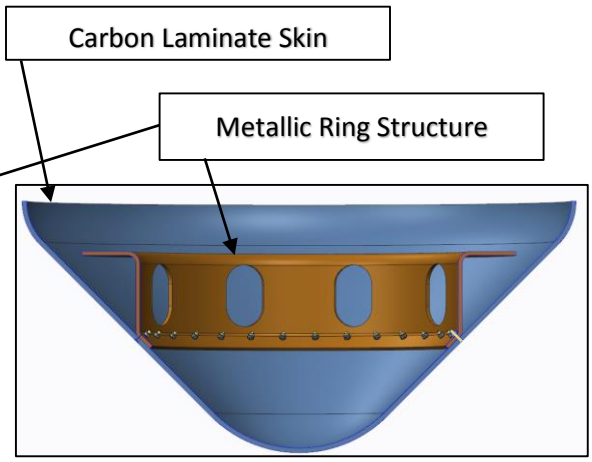

Figure 2 - Carrier Structure – Mid-Plane Sectioned View

2 APPLICABLE DOCUMENTS:

Copies of specifications, standards, drawings, and publications indicated as "required" by suppliers in connection with specified procurement functions shall be obtained from the NASA Contracting Officer. Documents beginning with the control number "A9SP" or "HEEET" are program documents controlled by the National Aeronautics and Space Administration (NASA).

NOTE TO RFP OFFERORS: The required project drawings and specifications may contain ITAR sensitive information. Offerors may request copies of these documents from the Contracting Officer. Include information about your company's capability to receive and handle ITAR information, (indicate US citizenship or US person status of all personnel who will have access to this Government information. This is a requirement to be considered for award.

2.1 GOVERNMENT DOCUMENTS

DOCUMENT NUMBER	TITLE	Use
HEEET -6001-001	Carrier Forebody Assembly	Required
HEEET -6002-001	Carrier Forebody Shell	Required
HEEET -6003-001	Carrier Ring	Required
HEEET -6004-001	Carrier Shipping Configuration	Required
HEEET -6005-001	Carrier 4-Point Bend Specimen	Required
HEEET -6006-001	Carrier Thermal Strain Panel	Required
HEEET -6007-001	Through Thickness Tension Specimen	Required
HEEET -6008-001	Carrier "TBD-A" Test Specimen	Option
A9SP-1501-REM-XR052	Structural Bonding of Composite Materials	Required
HEEET-4009	HEEET Carrier Structure Layup Specification	Required
HEEET-4010	HEEET Composite Material Specification	Required
A9SP-1501-REM-XR051	Composite Material Process Specification	Required
A9SP-1501-REM-XR010	Part Marking	Required

ASTM E-1495	Standard Guide for Acousto-Ultrasonic Assessment of Composites, Laminates, and Bonded Joints	Optional
AIA/NAS NAS 999	Nondestructive Inspection of Advanced Composite Structures	Reference
ASTM E-2533	Standard Guide for Nondestructive Testing of Polymer Matrix Composites Used in Aerospace Applications	Reference
ASTM E-2662	Standard Practice for Radiologic Examination of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications	Optional
ASTM E-2663	Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods	Optional
MIL-HDBK-17-2F	Composite Materials Handbook Volume 2. Polymer Matrix Composites Materials Properties	Reference
SAE AS 9100B	Quality Systems Aerospace Model for Quality Assurance in Design, Development	Reference

3 SOW REQUIREMENTS/PROCESS SPECIFICATION

This section outlines the SOW requirements and process specifications for the flat panel structures and of the ETU carrier structure.

3.1 ROLES AND RESPONSIBILITIES

The contractor may be referred to as the "the supplier", "the vendor", or "the contractor" synonymously within this SOW. The NASA Ames Research Center shall act as the customer performing buyoffs at all levels and phases of the contract. The references to NASA, ARC, NASA ARC, NASA Ames Research Center, and the Government shall be used interchangeably within this document. Quality oversight shall be conducted by NASA. All components shall be fabricated and tested by the contractor per process/SOW specification. NASA shall approve any substitution process proposed by the contractor.

3.2 SOW REVISIONS

The released mechanical drawing package provided by NASA (with the RFP, and at contract award) is the contractual vehicle by which the supplier shall fabricate or assemble all piece parts, components, or subassemblies into the specified deliverables.

In the event that NASA elects to revise the scope of work through the addition of new work tasks, Class I changes to drawings, and/or significant modifications to process specifications herein, advance notice of said changes will be communicated to the contractor by the Contracting Officer. Any scope changes shall be negotiated between the contractor and NASA with a subsequent contract modification issued for the scope change. Any subtasks related to this SOW, unless otherwise specified, shall fall under the same contractual obligations specified herein.

All changes to SOW Section 8 Deliverables shall be accomplished by contract modification 10 working days prior to any preship review.

3.3 MATERIAL LOT PURCHASING

The contractor shall procure sufficient raw composite materials in accordance with HEEET-4010 to cover all deliverables and options. All excess material (not including scrap) shall be delivered to ARC 30 working days prior to the end of the contract.

The handling/storing/shipping requirements of the raw material is defined in the specification HEEET-4010, which are mandatory at all times. In the event the contractor does not store the material properly the contractor shall be required to replace it at its own expense.

3.4 PROCESS SPECIFICATIONS

In all cases where hardware deliverables reference process specifications, compliance with those specifications is mandatory. The following is a list of the key specifications (but not limited to) required to complete the HEEET Composite Carrier Structure contract effort. These processes shall be made available in electronic PDF format as requested by offerors during the Request for Proposal, and at contract award:

- A9SP-1501-REM-XR052, Structural Bonding of Composite Materials
- HEEET-4009, HEEET Carrier Structure Lay-up Specification

- HEEET-4010, HEEET Composite Material Specification
- A9SP-1501-REM-XR051, Composite Material Processing Specification
- A9SP-1501-REM-XR010, Part Marking

All applicable and reference documentation identified in this document shall apply in the situations where they are specifically referenced. Unless a specific issue or revision is listed, the referenced documents shall be of that issue or revision in effect on the date of Request for Proposal (RFP). In the event of a conflict between the SOW and the specification, the SOW shall take precedence. See Appendix B for a list of referenced documents.

3.5 LACK OF/SUBSTITUTION/ALTERNATIVE WORK PROCESSES

In the event that NASA does not supply a required Work Process or the contractor selects an Alternative Work process, the contractor shall perform design, analysis, fabrication, and inspection of any additional tooling and or new processes required to produce the Deliverables stated in SOW Section 8. The contractor shall perform complete process and tooling validation concurrently with NASA ARC to finalize all manufacturing process details (beyond that contained in the supplied process specifications) or to resolve any discrepancies between test specimen and/or part design and the specified technical drawing.

3.6 ENGINEERING DOCUMENTATION

The contractor shall deliver all technical documentation required to produce the deliverables stated in SOW Section 8 including but not limited to: composite ply drawings, tooling or ground support equipment drawings, manufacturing or assembly work processes. The contractor shall document and deliver all analyses of any engineering work tasks associated with Section 4.6 including but not limited to: hand calculations, thermal analysis, tooling process developments, and inspection reports. A contractor selected format is suitable for this documentation, upon approval by NASA, 5 working days prior to the Manufacturing Readiness Review (MRR).

3.6.1 CONTRACTOR DRAWING PACKAGES

The contractor shall provide a drawing package that includes all mechanical detail and assembly drawings for manufacturing related components such as shipping containers, tools, molds, etc. that have not already been provided by NASA, or are proposed as replacements to those provided by NASA. All updates or changes to this drawing package shall also be delivered to NASA. This drawing package shall be reviewed during MRR.

3.6.2 MANUFACTURING PROCESS

The contractor shall prepare a Manufacturing Processes Package that contains any contractor specific manufacturing processes that will be utilized during fabrication of the delivered hardware. This package must describe any deviations from the NASA-supplied process specifications and will be reviewed at the MRR meeting. Approval of contractor processes and procedures shall be obtained at the conclusion of a successful MRR, with written approval from the NASA/ARC Contracting Officer's Representative (COR) for any deviations from the NASA-supplied process specifications.

3.6.3 PROCESS CONTROL

The contractor shall manufacture the deliverable hardware using documentation that lists the detailed manufacturing and processing steps required to manufacture and or test each deliverable item. The contractor shall use this documentation to list any deviations, changes, anomalies, and/or repairs that

occur during the manufacturing process and certify that each step has been performed as specified. ARC reserves the right to inspect all process and documentation.

3.6.4 ENGINEERING CHANGE PROPOSALS (ECP)

ECP's shall be submitted electronically to the CO/COR as required to request changes to any baseline documentation. Class I changes are those which affect form, fit, or function.

The contractor/ subcontractor shall not incorporate a change without prior written approval of the CO/COR. Departures from, or non-compliance with, the product specification shall be requested using an Engineering Change Proposal submitted to the Contracting Officer and COR. All outstanding deviations or waivers will be approved by ARC before the end-item is shipped.

3.6.5 NASA PROVIDED ENGINEERING DRAWINGS/MODELS

If required during the period of performance and/or proposal phase, electronic versions of models shall be exchanged in the following formats, listed in order of preference:

1. Pro Engineer Wildfire 5.0, CREO I or II
2. STEP 201
3. IGES
4. CATIA V5.0

A released drawing package shall be provided to prospective offerors upon request with the RFP, and at contract award. The drawing package shall contain the following type of drawings and documents:

- Final component or piece part drawings
- Assembly drawings
- Drawing Formats shall be provided in either PDF or hard copies.

The naming convention for NASA Ames Research Center engineering drawings in the HEEET project is:

HEEET-6XXX-YYY-Rev.ZZZ

Where XXX is the drawing number and YYY is the part number. Revision level ZZZ is either "-" indicating an initial release, or an alphabetic character.

A CD-ROM of the drawing/documents package shall be provided. All engineering drawings shall be rendered in Adobe Portable Document Format (PDF) at minimum "D" size resolution. The vendor may request alternate file formats.

3.6.6 VENDOR DELIVERED ENGINEERING DRAWINGS/MODELS

All vendor delivered CAD data, provided to NASA, shall be in the following formats, in order of preference:

- PTC Pro/E Wildfire 5.0, CREO I or CREO II
- Solidworks 2014 or 2015
- STEP 201
- IGES

All Vendor delivered engineering drawings, provided to NASA, shall be in the following formats, in order of preference:

- Native CAD System, PTC Pro/E or Solidworks

- PDF
- Hardcopy

3.7 DELIVERIES

The vendor shall be responsible for supplying packaging, packing and shipping of all deliverables defined within the task phases of Section 5 within 5 days of NASA acceptance. NASA will provide shipping containers, designated as Government Furnished Property (GFP), to transport the completed carrier structures (see Appendix C). Installation of the carrier structure into the shipping container shall be defined in drawing: HEEET-6004-001 (See SOW Appendix C).

4 MANAGEMENT AND REPORTING

The contractor shall establish and maintain management operations that shall include the following areas:

- Reviews and Meetings
- Subcontractor Control
- Schedule and Financial Management
- Engineering and Manufacturing Data Management
- Management and Accountability for Government Furnished Equipment, Material or Information.

4.1 ON-SITE GOVERNMENT REPRESENTATIVE

NASA reserves the right to have in-plant representation at the Contractor's facility and at all major subcontractor sites when performance/verification testing or other operations are being performed. This Government representation may be provided by NASA, or non-Government personnel designated by NASA.

The Contractor shall provide office accommodations for NASA-designated representatives at the Contractor's facility during visits and shall ensure that Government access privileges are included in any subcontract.

During this period, the NASA representative shall be onsite for validation of workmanship process, quality control and expedite mandatory inspection points.

4.2 NOTIFICATION

The contractor shall notify the NASA/ARC COR at least 48 hours in advance of all mandatory hardware inspections, test activities, and deliveries at either the Contractor's or a subcontractor's facility to allow timely participation by the NASA/ARC Quality Assurance personnel.

4.3 REVIEWS AND MEETINGS

The required meetings are outlined below. The NASA/ARC COR shall have the authority to remove the requirement for meetings. The elimination of reviews and/or meetings shall be captured by written NASA/ARC COR approval.

Summary Reports shall be submitted for all meetings and reviews and, at a minimum, shall include meeting notice, agenda, attendance, review meeting minutes, action items, action item accomplishment responsibility and agreements. The reports shall be distributed to all meeting attendees at not greater than 5 work days after the meeting, review, or TIM. Electronic PDF format sent by email shall be considered acceptable.

4.3.1 KICK-OFF MEETING

The Contractor shall organize and present a Kick-Off Meeting to a NASA Review Team at the Contractor's facility, unless otherwise agreed to by the contractor and NASA/ARC COR, no later than 10 business days after the contract award. The contractor shall establish that the baseline technical and manufacturing requirements are clearly understood and that procurement definition and manufacturing direction is complete as specified in this document, along with the HEEET Carrier Structure Deliverables List and Manufacturing & Delivery Schedule (SOW Section 8). This review shall also provide an opportunity to review drawings and manufacturing processes.

The contractor shall present a comprehensive presentation which lays out the approach and planning for the HEEET work task. The presentation shall cover but need not be limited to the following subjects:

- Programmatic structure definition of the HEEET work task including: WBS, personnel roles and responsibilities.
- Key manufacturing requirements which shall be met as defined in the SOW.
- Key manufacturing processes or contractor process which shall be met during the complete fabrication period.
- A Schedule covering all elements of the HEEET work tasks presented in Microsoft Project 2013 format.
- Status on material purchasing, engineering design work, tool fabrication. (Lead time of materials, dates of anticipated purchases, prospective vendors, anticipated shipping methods, etc.)
- A Configuration Management Process shall be described at Kick-Off Meeting or a Configuration Control Plan shall be submitted (see SOW Section 4.6.2).
- Overview of Quality Assurance Plan used to meet SOW requirements (see Section 6.1.1).

4.3.2 TECHNICAL INTERCHANGE MEETINGS (TIM)

For the purposes of design transition and communication the contractor is permitted to plan informal, face-to-face technical interchange meetings at the contractor facilities. The contractor shall support review and coordination of technical issues including, but not limited to manufacturing approaches, drawing details, engineering change notices/requests (ECN), and reviews of contractor proposed alternative work efforts. TIM's are intended to work out technical details prior to Manufacturing Readiness Reviews.

NASA/ARC or the Contractor may initiate a TIM. The said initiator shall provide notice a minimum of 7 working days prior to the proposed meeting date. The contractor shall budget supporting a minimum of 3 TIMs during the period of performance.

4.3.3 MANUFACTURING READINESS REVIEWS (MRR)

The Contractor shall organize and present a Manufacturing Readiness Review to a NASA Review Team at the Contractor's facility at a minimum of 5 working days PRIOR to each of the following manufacturing phases:

- Phase 0: Flat panel fabrication
- Phase 1: Carrier Structure Tool and Bracket fabrication
- Phase 2: Carrier Structure fabrication
- Any work task options cited herein
- As required by NASA/ARC, any subdivision of the aforementioned phases relating to the release of "traveler", "work instruction" or contractor specific process

Each review shall demonstrate overall conformance of the requirements for the aforementioned Phases as specified in this Statement of Work.

Review topics shall cover but are not limited to:

- Final approval (by signature) of any contractor derived manufacturing process.
- Final approval (by signature) of any drawing modifications
- Final approval (by signature) of any quality assurance related process
- Review of Manufacturing Schedule for that Phase/Segment
- Review of personnel, manpower supporting that Manufacturing segment.

Upon closure of any open items resulting from the MRR the contractor shall be considered ready to commence production/manufacturing.

4.3.4 WEEKLY STATUS MEETINGS (WSM)

Weekly status meetings shall be held at 9 A.M. Pacific Time each Monday, or a mutually agreed hour each week, during the period of performance at the Contractor facility. NASA/ARC COR will participate in person or via WebEx or Similar/Telecon. Minutes of the meeting shall be captured by the contractor in an email. Planned vs. Actual progress, shall be presented along with action item tracking and any other programmatic or technical topics.

4.3.5 PRE-SHIP REVIEW (PSR)

The Contractor shall hold a Pre-Ship Review at the contractor's facility at the completion of verification tests and prior to shipment of the Contract Line Items (CLIN) to ARC. A PSR shall be held prior to the delivery of each item. The PSR shall include presentation of the End Item Data Package (EIDP). The contractor shall deliver objective evidence with the hardware, showing product assurance acceptance of in-process workmanship, and final inspection. The contractor must implement all corrective actions necessary to remedy, before final acceptance, any nonconformance with respect to this SOW or the specifications noted on the design drawings. A government source inspection shall be required prior to shipment. ARC or its representative shall have final approval authority over all tests, verification, and documentation. All discrepancy report documentation shall be discussed and included as part of the EIDP. EIDP requirements are identified in section 4.6.3.

At the time of the PSR, documents and analysis to support fulfillment of the requirements of this SOW for the hardware being delivered shall be complete and all actions from previous reviews shall be closed.

4.4 PROJECT COORDINATION AND SUBCONTRACTOR CONTROL

The contractor shall designate and identify by name a single employee who shall serve as the point of contact (POC) with the NASA Ames Research Center Contracting Officer's Representative (NASA/ARC COR) for all technical aspects of the Carrier Structure contract. After contract award, the contractor POC shall obtain a NASA MINX-docs account from the COR for transfer of NASA documentation and technical data (ARC shall coordinate this access for the POC).

The contractor shall designate personnel who will be given full responsibility and authority to manage and administer all phases of the work specified by the contract and ensure that all objectives are accomplished within schedule and cost constraints.

In the event the Contractor elects to subcontract work tasks, the subcontractor shall conform to the same requirements stated herein to manage all program resources, control schedules, and manage engineering, manufacturing and procurement activities. The subcontractor shall perform all necessary configuration management, Quality Assurance, documentation control, and distribution functions.

4.5 SCHEDULE AND FINANCIAL MANAGEMENT

The Contractor shall establish a baseline schedule with Work Breakdown Structure (WBS) in accordance with all tasks specified herein. This schedule shall become a key component of weekly and monthly status reporting. The format shall be of a Gantt type using Microsoft® Project. Contract financial management

reporting requirements shall be in accordance with Contract Data Requirements List (CDRL) and contract clause Section G, NFS 1852.242-73, NASA Contractor Financial Management Reporting.

4.6 DATA MANAGEMENT (TRAVELERS, TECHNICAL REPORTS, ETC.)

The contractor shall maintain internal documentation to control the flow of work through all manufacturing steps. A "traveler", or "work instruction" is recommended for tracking history of process related steps as applied to manufacturing. The contractor shall maintain and deliver all electronic correspondence, CAD models, and related electronic data throughout program life cycle. For each review, the contractor shall provide to ARC a Review Presentation Package including all relevant deliverables no less than 5 work days prior to the review. Electronic PDF format sent by email shall be considered acceptable.

4.6.1 MONTHLY PROGRESS REPORTS (MPR)

This report shall cover programmatic, technical, test and verification, and quality assurance progress and status. Report is due by the second Tuesday following month being reported. This report shall also include a review of all tooling design, test plans and procedures and all analyses required to convey project status. This report shall demonstrate continued conformance to the requirements specified in this SOW appropriate to the fabrication phase, including:

- A summary of work accomplished
- A summary of problems encountered
- A list of any monthly nonconformance and their resolutions
- Summaries of inspection and test activities
- Copies of written approvals for deviations from approved drawings
- As required by the COR: copies of material certifications and certificates of conformance for raw materials received that period.
- A snapshot/copy of the current working schedule (Microsoft Projects®)
- A snapshot of contract financial status/ cost risks

4.6.2 CONFIGURATION CONTROL PLAN

The contractor shall deliver a Configuration Control Plan at the Kickoff Meeting (SOW 4.3.1) which describes the following:

1. Configuration management organization, methods, procedures, and controls
2. Configuration identification
3. Change control and change management processes
4. Status accounting
5. Configuration control audits

4.6.3 END ITEM DATA PACKAGE (EIDP)

The contractor shall provide documentation verifying that each contract line item deliverable meets the requirements of the specification. This data package shall be approved by contractor Quality Assurance and contain at a minimum, the following items:

1. All documentation per A9SP-1501-REM-XR051
2. All documentation per A9SP-1501-REM-XR052

3. All documentation per HEEET-4009
4. All documentation per HEEET-4010
5. All documentation per A9SP-1501-REM-XR010
6. List and status of all identified Life-Limited Items
7. Dimensional Inspection Reports
8. Results of Non-Destructive Examination
9. Certification of Conformance signed by an officer of the company
10. Nonconforming material reports occurring during end-item acceptance tests
11. As built manufacturing processes (contractor specific)
12. Material certifications for all materials in the end item

Contractor format is acceptable upon approval from the Government. The contractor shall deliver two copies of each EIDP as described above. One hard copy shall be enclosed with the hardware shipment. An electronic copy of the EIDP (PDF format preferred) shall also be delivered to the NASA COR.

5 CONTRACTOR TASKS/WORK PHASES

The work tasks shall be structured in the following manner:

- Phase 0 Task: Flat Panel fabrication
- Phase 1 Task: Carrier structure tooling and Bracket fabrication
- Phase 2 Task: Carrier Structure fabrication
- Phase 3 Task: Options
    - Option A - Task: Carrier Thermal Strain Panel
    - Option B - Task: Additional Composite Panel

The delivery schedule is specified in Section 8 Deliverables. For the purposes of validation, Phase 0 and Phase 1 Deliveries shall be concurrent. Delivery is further requested “as available” or “as completed” therefore this SOW states deliveries as “no later than”. The contractor’s proposal shall take this delivery cycle into account.

ACCELERATED SCHEDULE: The contract also provides an additional firm fixed price amount to be paid to the contractor for successful accelerated delivery and Government acceptance of Phase 0 and Phase 2 deliverables (see contract clause B.6).

5.1 PHASE 0: FLAT PANEL FABRICATION

Fabricate flat panel test specimens, per specified technical drawing, and all requirements defined as part of the SOW:

- HEEET-6005-001 Carrier 4-Point Bend Specimen
- HEEET-6007-001 Through Thickness Tension Specimen

Phase 0 Deliverables:

- HEEET-6005-001 Carrier 4-Point Bend Specimen **Quantity: 39x**
- HEEET-6007-001 Through Thickness Tension Specimen **Quantity: 18x**
- Contractor Drawing Package – for any technical documentation covering Phase 0 tasks.
- Manufacturing Process – for all manufacturing steps associated with Phase 0 tasks.
- End Item Data Package – Covering all "HEEET-6005" Carrier 4-Point Bend Specimens
- End Item Data Package – Covering all "HEEET-6007" Through Thickness Tension Specimen

5.2 PHASE 1: CARRIER STRUCTURE TOOLING

Design/develop all engineering deliverables required to fabricate a completed Carrier Structure, this includes but is not limited to: ply/seam planning, ply drawings, ply assembly process, all tooling drawings, procurement plan required to fabricate piece parts and purchase fasteners, and assemble complete carrier structure. Fabricate all tooling.

Carrier Structure defined by the following drawings:

- HEEET-6001-001 Carrier Forebody Assembly
- HEEET-6002-001 Carrier Forebody Shell
- HEEET-6003-001 Carrier Ring

Phase 1 Deliverables (Required for Phase 2 MRR):

- Contractor Drawing Package – for any technical documentation covering Phase 1 tasks.
- Manufacturing Process – for all manufacturing steps associated with Phase 1 tasks.
- All tools needed to fabricate piece parts of the carrier structure and assemble the carrier structure
- Inspection reports on all tooling, verification that they will meet fabrication requirements

5.3 PHASE 2: CARRIER STRUCTURE FABRICATION

Fabricate Carrier Structure, per specified technical drawing, and all requirements defined as part of the SOW:

Carrier Structure defined by the following drawings:

- HEEET-6001-001 Carrier Forebody Assembly
- HEEET-6002-001 Carrier Forebody Shell
- HEEET-6003-001 Carrier Ring

Phase 2 Deliverables:

- HEEET-6001-001 Carrier Forebody Assembly **Quantity: 2x**
- Contractor Drawing Package – for any technical documentation covering Phase 2 tasks.
- Manufacturing Process – for all manufacturing steps associated with Phase 2 tasks.
- End Item Data Package – Covering Serial #1 "HEEET-6001-001" Carrier Forebody Assembly
- End Item Data Package – Covering Serial #2 "HEEET-6001-001" Carrier Forebody Assembly

5.4 PHASE 3: OPTIONS

5.4.1 PHASE 3 OPTION A - TASK: CARRIER THERMAL STRAIN PANEL

Fabricate flat panel test specimens, per specified technical drawing, and all requirements defined as part of the SOW:

- HEEET-6006-001 Carrier Thermal Strain Panel

Phase 3 – Option A Deliverables:

- HEEET-6006-001 Carrier Thermal Strain Panel **Quantity: 1x**
- Contractor Drawing Package – for any technical documentation covering Phase 3 Option A tasks.
- Manufacturing Process – for all manufacturing steps associated with Phase 3 Option A tasks.
- End Item Data Package – Covering all "HEEET-6006-001" Carrier Thermal Strain Panel

5.4.2 PHASE 3 OPTION B - TASK: ADDITIONAL COMPOSITE PANEL

Fabricate flat panel test specimens, per specified technical drawing, and all requirements defined as part of the SOW:

- HEEET-6006-001 Additional Composite Panel
- *48" x 48" x 0.3" thick of flat composite panel material, layup identical to* HEEET-6006-001*.*

Phase 3 – Option B Deliverables:

- HEEET-6006-001 Additional Composite Panel **Quantity: 1x**
- Contractor Drawing Package – for any technical documentation covering Phase 3 Option B tasks.
- Manufacturing Process – for all manufacturing steps associated with Phase 3 Option B tasks.
- End Item Data Package – Covering all "HEEET-6006-001" Additional Composite Panel

5.5 GOVERNMENT FURNISHED EQUIPMENT (GFE)

Contractors electing to not use the existing NASA –provided GFE shall justify the reason and shall itemize the non-recurring and recurring engineering costs in the response to this statement of work. All GFE is listed in Appendix C.

5.6 TOOLING HARDWARE DELIVERABLES

All tooling designed, fabricated and used for the manufacture of the HEEET related hardware in this SOW shall be delivered to NASA upon completion of Phase 3. Final contract invoice payments shall not be approved prior to acceptance of tooling hardware deliverables.

5.7 COMPOSITE MATERIAL SCRAP & SPARE MATERIAL

All composite panel material scrap/drops greater than 2 square inches, all unused metallic material, and all spare fasteners shall be collected and delivered to NASA no less than 30 days before the final day of contract performance. Any prepreg scrap shall be stored and shipped in accordance with HEEET-4010.

6 QUALITY ASSURANCE

6.1 GENERAL REQUIREMENTS

6.1.1 QUALITY MANAGEMENT SYSTEM

The contractor shall implement product assurance efforts sufficient to assure the delivered product meets all contractual requirements. The contractor's Quality Management System compliance to AS9100 is strongly recommended. The contractor shall provide both a Quality Management System Manual and a preliminary Quality Assurance Plan in the response to SOW / RFP. A final Quality Assurance Plan shall be delivered at the Kick-Off Meeting.

The Quality Assurance Plan shall define the general polices, controls, procedures, and approaches to be followed in implementing all phases of the end item product assurance program. This plan shall address the following product assurance related functions:

1. Hardware Quality Assurance

Contractor format is acceptable.

ARC Chief Safety Officer (CSO) or their representative reserves the right to conduct inspections, process review, perform audits, and witness testing at the contractor or any lower-tier subcontractor, with prior notification.

6.1.2 GOVERNMENT SOURCE INSPECTION

The Government may elect to perform inspections. The following statement shall be included on all procurement documents: "All work on this order is subject to inspection and test by the Government at any time and place".

The Government representative shall also be notified 48 hours in advance of the time that articles or materials are ready for inspection or test.

6.1.3 CONTRACTOR SOURCE INSPECTION

The contractor shall ensure that its procurement documents impose the applicable requirements on subcontractors and other suppliers. The subcontractor and other suppliers shall in turn impose the requirements on their procurement sources.

6.1.4 GOVERNMENT MANDATORY INSPECTION POINTS (MIPS)

The ARC CSO or designee will perform MIPs defined by procedures or processes specified herein. The government may impose additional MIPs if a new process or specification is proposed by the contractor.

6.2 NONCONFORMANCE

The contractor shall implement a nonconformance control system that documents, segregates, and dispositions any material or product that does not conform to the requirements of the applicable drawing, specification, or contract.

Any nonconformance (discrepancy), regardless of nature or where discovered, shall be documented. The NASA COR has authority to initiate a Material Review Board (MRB). The material shall be positively identified. The contractor should perform a preliminary review of such item(s) and make a disposition as follows:

(a) *Scrap* — If the item(s) are determined unfit for use, they should be scrapped.

(b) *Return to subcontractor* — If procured item(s) are unacceptable, they should be returned to the subcontractor.

(c) *Complete or rework to specification* — If the item(s) can be completed or reworked to drawing and/or specification requirements.

All finalized nonconformance reports shall be included in the EIDP, and shall be available for review by ARC at the contractor's facility. The contractor shall not ship any nonconforming articles unless authorized by ARC.

6.2.1 DISPOSITION OF NONCONFORMANCES

Non-conformances shall be dispositioned as follows:

a) The contractor shall submit all dispositioned non-conformance reports (repair, use-as-is, and acceptance and qualification test dispositions) to ARC for approval. Nonconformance reports may be in the contractor's format.

b) Each interim disposition of a nonconformance shall be separately approved by ARC.

c) ARC shall be notified and a formal nonconformance report shall be submitted within two (2) calendar days of a non-conformance. ARC will respond within five (5) work days of receiving the request.

d) In urgent situations, the contractor shall notify the appropriate ARC COR by telephone, followed within 24 hours by a confirming e-mail. The COR shall receive the non-conformance from the contractor and submit it to the ARC Material Review Board (MRB) for immediate action. The COR will notify the contractor by email message, or telephone of MRB action and will email formal disposition instructions for the nonconformance to the contractor.

e) The contractor's nonconforming materials report shall cross-reference the applicable nonconformance report.

6.2.2 MATERIAL REVIEW BOARD (MRB)

In the event of a discrepancy, a MRB shall be formed. The MRB will investigate root causes and identify corrective actions. The board shall consist of contractor and NASA members.

6.3 CERTIFICATION AND CALIBRATION OF TEST EQUIPMENT

The contractor shall only perform testing with equipment that has a current calibration and/or certification.

6.4 WORKMANSHIP STANDARDS AND PROCESSES

The vendor shall provide documentation of the workmanship standards on all structures. The workmanship standard shall be presented at the MRR(s). The standard shall define the minimum acceptance criteria applied to flight hardware produced by the contractor. This shall include, as a minimum:

1. A list of the manufacturing processes to be verified.
2. The pass/fail criteria for the processes
3. The inspection methods used to verify the processes

6.5 MATERIALS & PROCESSES

The contractor's selection of materials and processes used in manufacture and test of the deliverables shall be in compliance with the requirements of this document and the associated specification. It is important that all organic materials, solvents, etc. used during manufacture, processing, cleaning, and packaging be carefully controlled to eliminate sources of outgassing or contamination. A list of all materials and processes to be used in the deliverable items shall be provided to ARC for approval. The material list shall contain as a minimum:

Organics:

1. HEEET-4010 and A9SP-1501-REM-XR051

Inorganics:

1. Material and Temper
2. Material Specification
3. Material Finish and Specification

Processes:

1. Process specification Number and Title

Contractor format is acceptable.

The contractor shall assure the implementation of a system to review GIDEP Alerts and customer furnished NASA Advisories for materials and processes, take appropriate action, and notify NASA of impacts or significant problems. This activity shall continue throughout the contract lifecycle. The subcontractor will provide a review matrix of all applicable Alerts and Advisories that impact furnished hardware along with actions taken.

6.5.1 LIMITED-LIFE ITEMS

The contractor shall identify, procure, and manage limited-life items. Limited-life items include all materials that are subject to degradation because of limited shelf life or freezer out-time. This includes all Carbon Fiber Reinforced Polymer and related adhesives. All limited life items such as these shall have detailed logs tracking their storage and use per HEEET-4010.

7 CONTAMINATION CONTROL REQUIREMENTS

The Contractor shall maintain cleanliness during manufacture of all hardware in accordance with NASA Ames Research Center Document Specifications:

- HEEET-4010, HEEET Composite Material Specification
- A9SP-1501-REM-XR051, Composite Material Processing Specification

8 DELIVERABLES

Item	Identifier	Description	Due Date	QTY	Phase
1	HEEET-6005-001	Carrier 4-Point Bend Specimen	No later than 84 calendar days/ 12 weeks After Contract Award	39	0
2	HEEET-6007-001	Through Thickness Tension Specimen	No later than 84 calendar days/ 12 weeks After Contract Award	18	0
3	Vendor Provided	Contractor Drawing Package, Manufacturing Process, Tooling Necessary to support Phase 2 work	No Later than 100 calendar days After Contract Award	TBD	1
4	HEEET-6001-001	Carrier Forebody Assembly	No later than 182 calendar days After Contract Award	1	2
5	HEEET-6001-001	Carrier Forebody Assembly	No later than 238 calendar days After Contract Award	1	2
6 (Option A)	HEEET-6006-001	Carrier Thermal Strain Panel	No later than 56 calendar days After Option Exercise	1	3
7 (Option B)	HEEET-6006-001	Additional Composite Panel, 48” x 48” x 0.3” thick of flat composite panel material, layup identical to HEEET-6006-001. Per SOW Section 5.4.2:	No later than 42 calendar days After Option Exercise	1	3

APPENDIX A: ABBREVIATIONS AND ACRONYMS

ABBREVIATION/ ACRONYM	DEFINITION
ABML	As-Built Materials List
ABPL	As-Built Parts List
ADC	After Date of Contract
AIP	Assurance Implementation Plan
ANSI	American National Standards Institute
ARC	Ames Research Center
CAD	Computer Aided Design
CAGE	Commercial and Government Entity
C&DH	Command and Data Handling
CCB	Configuration Control Board
CDR	Critical Design Review
CFRP	Carbon Fiber Reinforced Polymer
CLIN	Contract Line Item Number
CM	Configuration Management
CO	Contracting Officer
COR	Contracting Officer's Representative
CSO	Chief Safety Officer
CVCM	Collected Volatile Condensable Mass
DCR	Design Conformance Review
DPA	Destructive Physical Analysis
EO	Engineering Order
ESD	Electrostatic-Discharge
ETU	Engineering Test Unit
FEM	Finite Element Model
FMEA	Failure Modes and Effects Analysis
FOB	Freight On Board
FRB	Failure Review Board
FU	Flight Unit
GFE	Government Furnished Equipment
GIDEP	Government/Industry Data Exchange Program
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSI	Government Source Inspection
HEEET	Heatshield for Extreme Entry Environment Technology
ICD	Interface Control Document
IML	Inner Mold Line
IRT	Infrared Thermography
MAR	Mission Assurance Requirements
MDU	Manufacturing Demonstration Unit

ABBREVIATION/ ACRONYM	DEFINITION
MIL	Materials Identification List
MIP	Mandatory Inspection Point
MGSE	Mechanical Ground Support Equipment
MRB	Material Review Board
MRR	Manufacturing Readiness Review
MUA	Materials Usage Agreement
NDE	Non-destructive Examination
NSPAR	Non Standard Parts Approval Request
OML	Outer Mold Line
PER	Pre-Environmental Review
PIL	Parts Identification List
PM	Propulsion Module
PSR	Pre-Ship Review
PWB	Printed Wiring Board
QA	Quality Assurance
QCM	Quartz Crystal Microbalance
ROM	Rough Order of Magnitude
R&QA	Reliability and Quality Assurance
SCC	Stress Corrosion Cracking
S/C	Spacecraft
SMA	System Safety and Mission Assurance
SOW	Statement of Work
TML	Total Mass Loss
TIM	Technical Interchange Meeting
TO	Technical Officer
TQCM	Temperature Controlled Quartz Crystal Microbalance
TRL	Technology Readiness Level
UT	Ultrasonic Test
WVR	Waiver

APPENDIX B: LIST OF REFERENCED DOCUMENTS

All referenced documentation identified in the SOW shall apply in the situations where they are specifically referenced.

DOCUMENT NUMBER	TITLE
541-PG-8072.1.2	GSFC Fastener Integrity Requirements
AIA/NAS NAS 999	Nondestructive Inspection of Advanced Composite Structures
APR 7120.8	Program/Project Reviews for Space Flight Systems
ANSI/ESD S20.20	Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
ASTM E-1495	Standard Guide for Acousto-Ultrasonic Assessment of Composites, Laminates, and Bonded Joints
ASTM E-1556	Standard Specification for Epoxy Resin System for Composite Skin, Honeycomb Sandwich Panel Repair
ASTM E-2533	Standard Guide for Nondestructive Testing of Polymer Matrix Composites Used in Aerospace Applications
ASTM E-2662	Standard Practice for Radiologic Examination of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications
ASTM E-2663	Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods
ASTM E-595	Standard test method for total mass loss and collected volatile condensable materials from outgassing in a vacuum environment
MIL-HDBK-17-2F	Composite Materials Handbook Volume 2. Polymer Matrix Composites Materials Properties
MIL-STD-882	Standard Practice for System Safety
MIL-STD-889	Dissimilar Materials
MSFC-STD-3029	Multiprogram/project common-use document guidelines for the selection of metallic materials for stress corrosion cracking resistance in sodium chloride environments
NASA-STD-6001	Flammability, odor, off-gassing and compatibility requirements & test procedures for materials in environments that support combustion
NASA-STD-8739.7	Electrostatic Discharge Control
NPD 8730.5	NASA Quality Assurance Policy
NPR-8715.3	NASA General Safety Program Requirements
RSM 2002B	Range Safety Manual, WFF; Revision B
S-311-M-70	Destructive Physical Analysis. Equivalent

APPENDIX C: LIST OF GOVERNMENT FURNISHED EQUIPMENT (GFE)

Item Name	Part Number	Quantity
HEEET ETU/MDU Shipping Container	HEEET-6212-101	2
ETU Adapter	HEEET-6213-001	2
ETU Handling Fixture	HEEET-6214-001	2
Bolts/washers/etc. for shipping configuration	N/A	AR